What is a Tailings Dam?

Highland Valley Copper Mine, Logan Lake, British Columbia, Canada

Image 2: Mccosker Contracting Ltd: http://www.mccoskers.com.au
Pebble Tailings Storage Facilities (TSFs)
Recent Tailings Dam Failures

Brumadinho, Brazil, 2019

Samarco, Brazil, 2015

Mt. Polley, BC 2014 (Knight Piésold design)

irreversible-environmental-damage.html
https://www.theguardian.com/world/2019/jan/25/brazil-dam-collapse-news-latest-mining-
disaster-brumadinho
“Dams designed with downstream construction methods are less likely to fail than dams using centerline construction methods, especially under seismic shaking (ICOLD 2018).”

“The centerline construction method was selected for the bulk TSF north embankment to limit the footprint and volume of materials required for construction”

- Pebble Mine Draft EIS, p. 4.27-73
Draft EIS is Misleading about Failure Probability

“The probability of a full breach of the bulk or pyritic TSF tailings embankments was assessed to be extremely low”

- DEIS p. 4.27-72

“[a full tailings breach was] ruled out as remote during the 20-year operational life due to likelihood of successful detection and intervention”

- FMEA, October 2018
Draft EIS Did NOT consider a TSF failure

Breach Volume Released vs Tailings Storage Facility Capacity

- **Rico (2008) Equation**: $y = 0.354x^{1.008}$
- **Samarco**: $5.50 \times 10^7$
- **Mt Polley**: $2.36 \times 10^7$
- **Pebble TSF North**: $3.42 \times 10^8$

- **Breach Volume Released** vs **Tailings Storage Facility Capacity**
  - *Obs Breach Event*
  - *PLP BTN Rico Est Breach*
  - *EIS Bulk Tailings "Pipeline Rupture"*
  - *Power (Vf Rico (2008))*

- **Approximately 10,000x** the volume of the EIS Bulk Tailings "Pipeline Rupture" event compared to other breaches.
Our Goals and Approach

• Simulate the spatial extent of impacts in the event of a tailings dam failure at the Pebble Mine
• Develop scenarios based on historical TSF failures
• Use modeling framework consistent with prior industry practice (e.g., Knight Piesold, 2014; TetraTech, 2015)
• Explore sensitivity of outcomes to different physical and model parameters
  • Tailings sediment concentration
  • Tailings rheology (flow properties)
  • Duration of breach
  • Digital topographic dataset
  • Channel and valley “roughness”
• Examine results in the context of impacts to salmon habitat
Model Domain – Tailings runout

~125 miles to Dillingham
Breach Scenario Simulations

Model runs explored a range of breach scenarios:

- **Tailings volume released**
  - Rico et al. (2008) → 41% release
  - Low estimate → 10% release
  - High estimate → 60% release

- **Duration of breach event**
  - Varied from 6hr to 96hr
  - Influences peak discharge rate

- **Max sediment concentration**
  - Varied from 35%-50%
  - Influences flow properties
Result: 24-hour Breach, 50 hr simulation
Sensitivity: Total volume released

Breach Volume Comparison

10% breach volume (green)
- Inundated Area: 60.9 mi²

60% breach volume (orange)
- Inundated Area: 110.3 mi²
Sensitivity: Duration of Breach

11-hour breach inflow

CROSS SECTION OUTPUT: DISCHARGE (CMS)

24-hour breach inflow

CROSS SECTION OUTPUT: DISCHARGE (CMS)
Sensitivity – Duration of Breach (11 hr)
Sensitivity – Duration of Breach (96 hr)
24-hour Breach: Larger Model Domain

Edge of Model Domain

Bristol Bay

208 River Miles

Lliamna Lake
Larger Model Domain: 24-hour Breach

Model extends from TSF to Nushagak-Mulchatna Confluence

- ~45% of tailings are deposited within the model floodplain
- ~55% of tailings flow past the model boundary
Anadromous Waters Affected – 24 Hour Event

Tailings would directly impact >219 miles of anadromous waters
Potential impacts to the fishery

• Deposition of fine-grained tailings in spawning habitat could decrease emergence success (e.g., Chapman, 1988; Kondolf, 2000)

• Leaching of metals from tailings could create acute or chronic toxicity to salmonids


Long-term impacts

“Unrecovered tailings that are exposed to oxygen could generate acid on a timescale of years to decades...acid and heavy metals that accumulate in streambed sediments, wetland soils, or isolated waterbodies could impact water quality on a timescale of decades.”

- Pebble DEIS, page 4.27-65

“Recovery of a massive release, especially one that reaches flowing water, would be extremely difficult.”

- Pebble DEIS, page 4.27-65
“The only common factor in all major TSF failures has been human error, including errors in design, construction, operations, maintenance, and regulatory oversight.”

- Pebble DEIS, p. 4.27-71
Questions

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Model Domain – Mine Layout
Our Project Goals

• Simulate the spatial extent of impacts in the event of a tailings dam failure at the Pebble Mine
• Overlay this distribution with information on essential fish habitat
• Rely to the maximum extent possible on physical information from PLP and from analysis of previous failures

“If tailings come out, it will kill fish for about 20 miles down the north fork of the Koktuli. And that's it. And in 10 years, they'll come back naturally.”
- Tom Collier, Pebble CEO, 2018
Tailings Release Volumes

Tailings Storage Facility Capacity vs. Breach Volume

Max Breach Scenario Tested - 60% of Capacity
Min Breach Scenario Tested - 10% of Capacity

PLP BTN Rico Est Breach 3.42E+08
Samanco 5.50E+07
Mj Polley 2.36E+07
Rico (2008) Equation ~41%
y = 0.354x1.008

EIS Bulk Tailings "Pipeline Rupture" 4.42E+04

Obs Breach Event  PLP BTN Rico Est Breach  EIS Bulk Tailings "Pipeline Rupture"  Power (Vf Rico (2008))